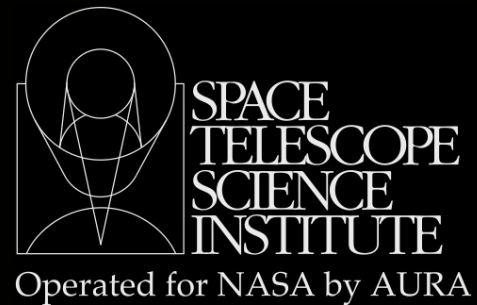


# Exploring the Cosmos

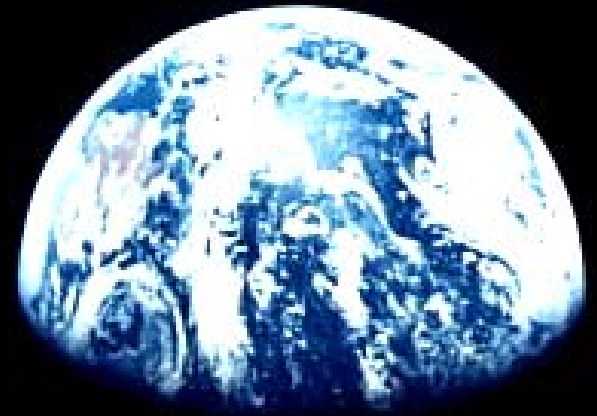


John Mace Grunsfeld PhD  
Space Telescope Science Institute

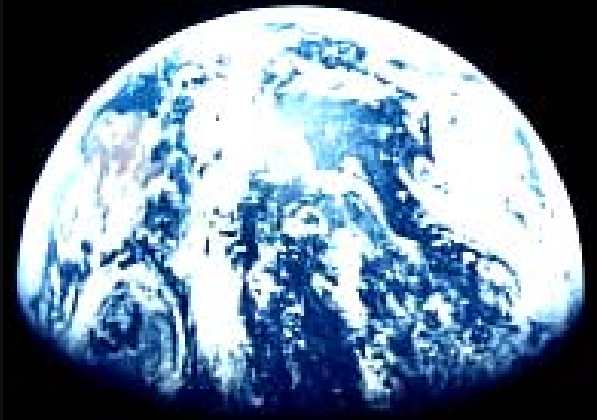


# Science is Exploration!

Science attempts to answer fundamental questions about our planet, our solar system, our universe and ourselves.

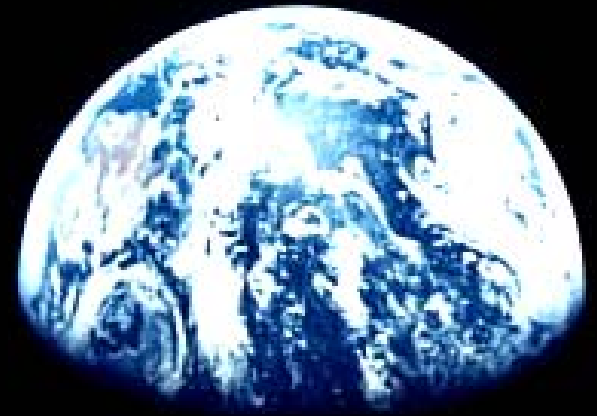


# Science is Exploration!



We are born as explorers, as scientists

# Science is Exploration!



The NASA FY2011 budget supports the creation of the building blocks for all exploration while enabling the scientific discoveries that will shape our future.



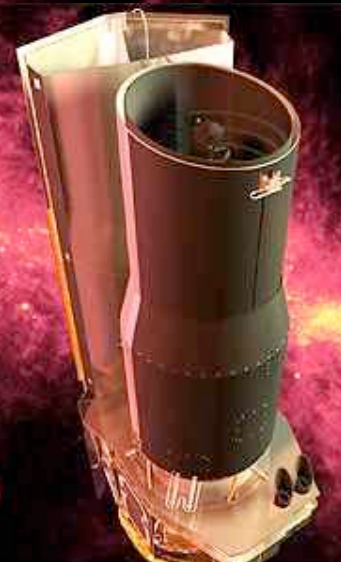
# NASA Science Rocks!



**CHANDRA**  
X-RAY OBSERVATORY



*Hubble*



**SPITZER**  
SPACE TELESCOPE



**CASSINI-HUYGENS**

*Voyager*  
The Interstellar Mission



*Kepler*



Solar Dynamics Observatory

# Science on the home planet: Earth



## Earth Science:

It is critical that we gain a systems understanding of the Earth as a system.

The FY2011 budget makes a substantial commitment to Earth and Climate Science commensurate with the importance of gathering new data and modeling to support policy decisions.

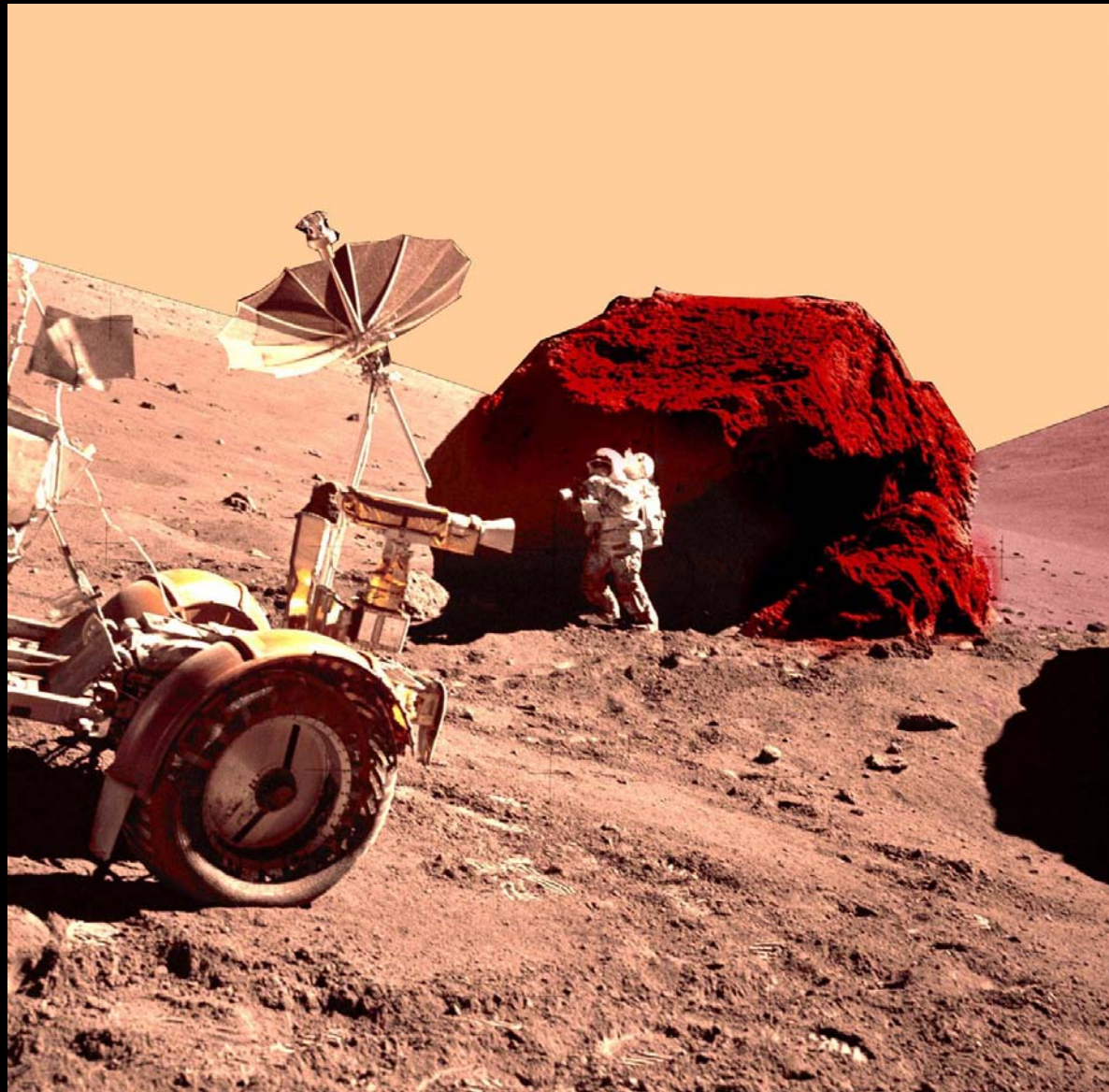
# Where should we go?

Low Earth Orbit, Lunar  
Surface, Deep Space, Near  
Earth Objects, Mars, Beyond?

We should go to those compelling places  
that offer unique opportunities for  
expanding our knowledge and building our  
capabilities to explore.

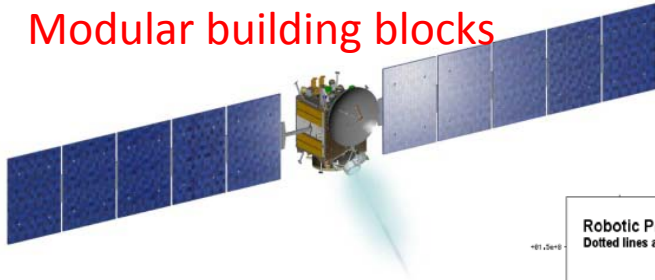


Mars! But how do we get there?

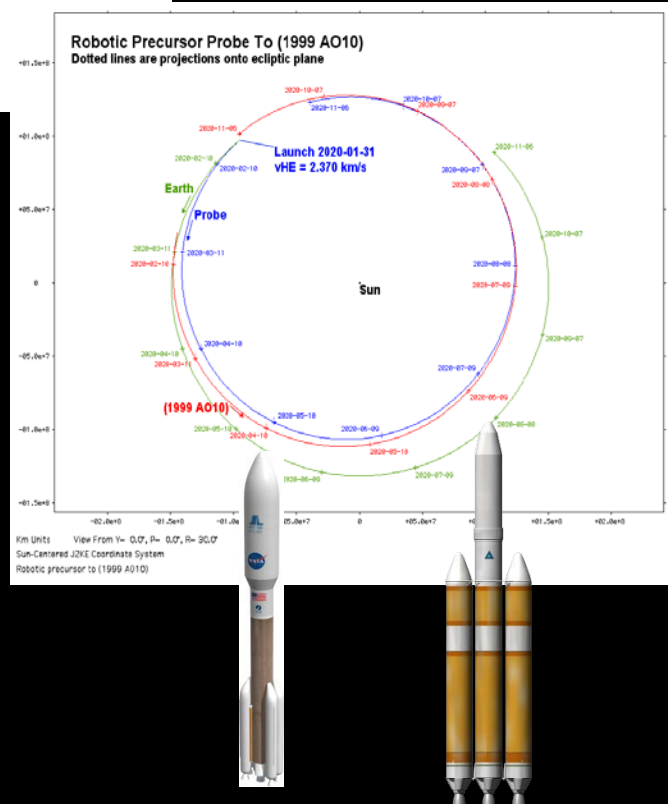


# Robotic precursors can precede human missions to all accessible targets

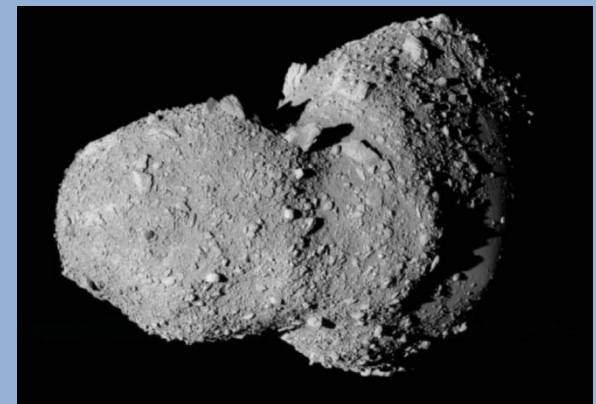
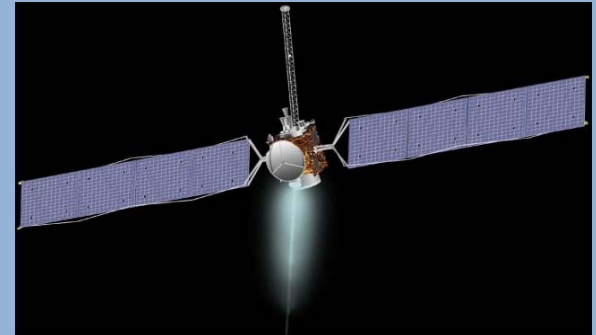
Modular building blocks



Basic Reconnaissance

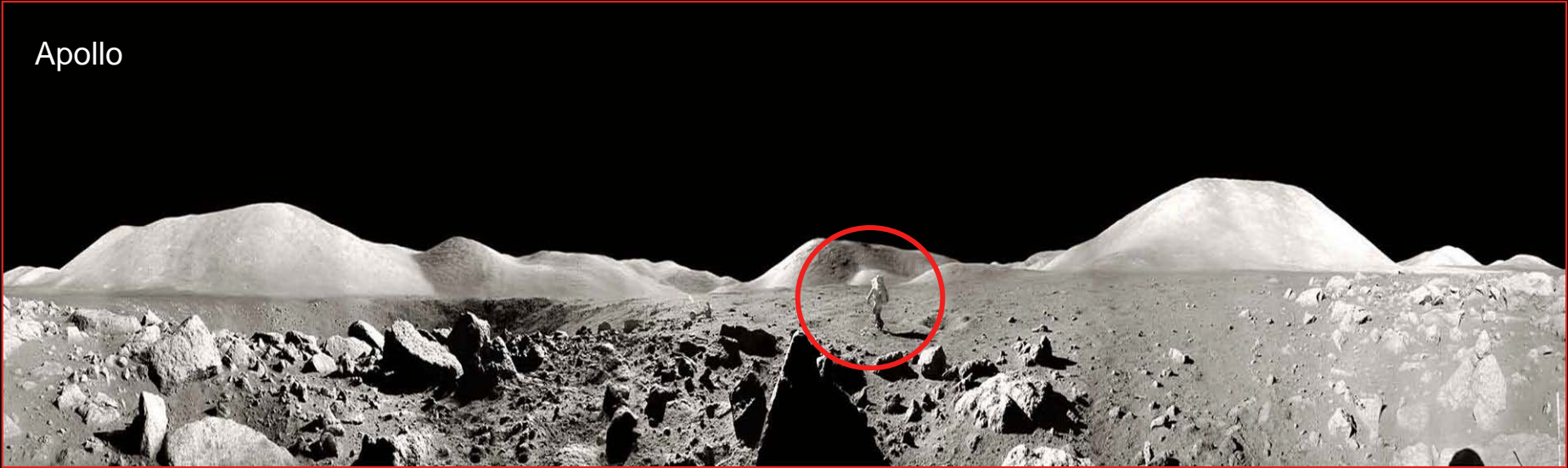


Many possibilities: multiple  
NEO rendezvous, *in situ*  
science, sample return, hazard  
mitigation demo



# Direct Human experience in space fundamentally alters our perspective

Apollo



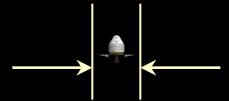
*MER Opportunity*

*Each Near Earth Object is a unique world to explore, and someday one may become hazardous to civilization*

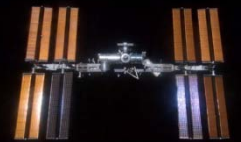


540 m asteroid Itokawa (Hayabusa 2005, JAXA)

Capsule



~15 m

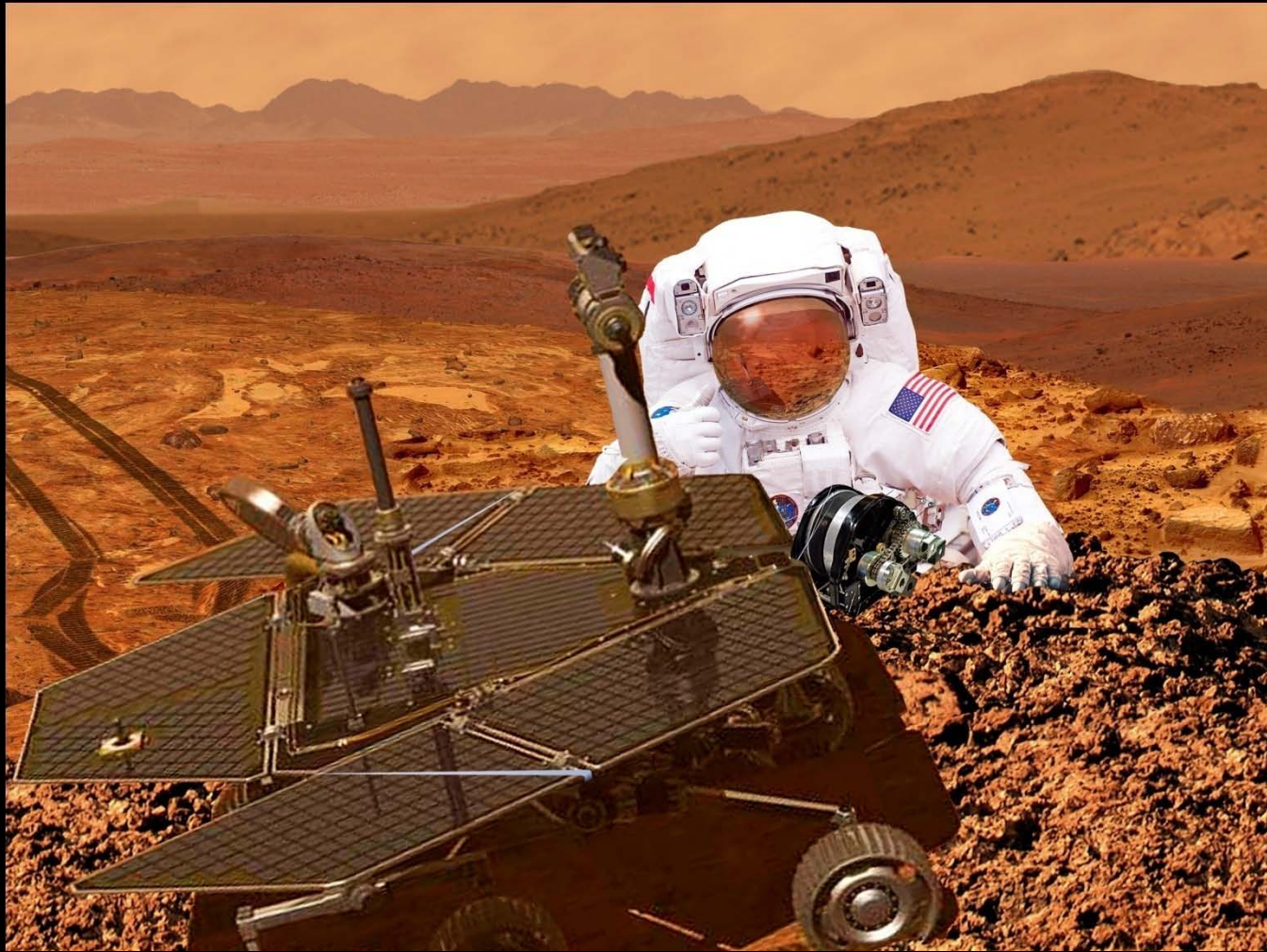


ISS

~110 m

By exploring a NEO we extend our experience further from LEO, and demonstrate that we can make better decisions than the dinosaurs. A visit to a NEO would be a truly historic and significant event in human history!

# Human/Robotic Partnership



Astronaut rescuing Mars Rover Spirit from a tough spot.

Risk:

We take great risks and engage in high performance challenges when the outcomes are significant.

## EDITORIAL

# This is why we fly

The Hubble repair mission showcases the value of the manned space program.

**T**HE billion-dollar Hubble Space Telescope boasts astounding accomplishments. For nearly two decades, this window to the universe has peered back millions of years in time to produce stunning photographs of stars, nebulae and galaxies whose light took e-

But the Hubble, launched with a flawed lens and fuzzy vision, would have been remembered as a colossal blunder had not the brave men and women of NASA been prepared to fly into space to install corrective optics.

For those who continue to question the necessity for a human role in the exploration of space, the marvelous achievements this past week of physicist, astronomer and astronaut John Grunsfeld and his shuttle Atlantis crew mates provide an inspiring answer.

In five grueling spacewalks to revive the aging Hubble, the astronauts demonstrated why human hands and minds in orbit remain indispensable.

The spacewalking mechanics, encumbered by bulky gloves and spacesuits, successfully pulled off unprecedentedly complex repairs. Nearly 37 hours of maintenance, installation and rehab work on the telescope not only restored the universe, but expanded its capabili-

ties to probe even further into the mysteries of the cosmos.

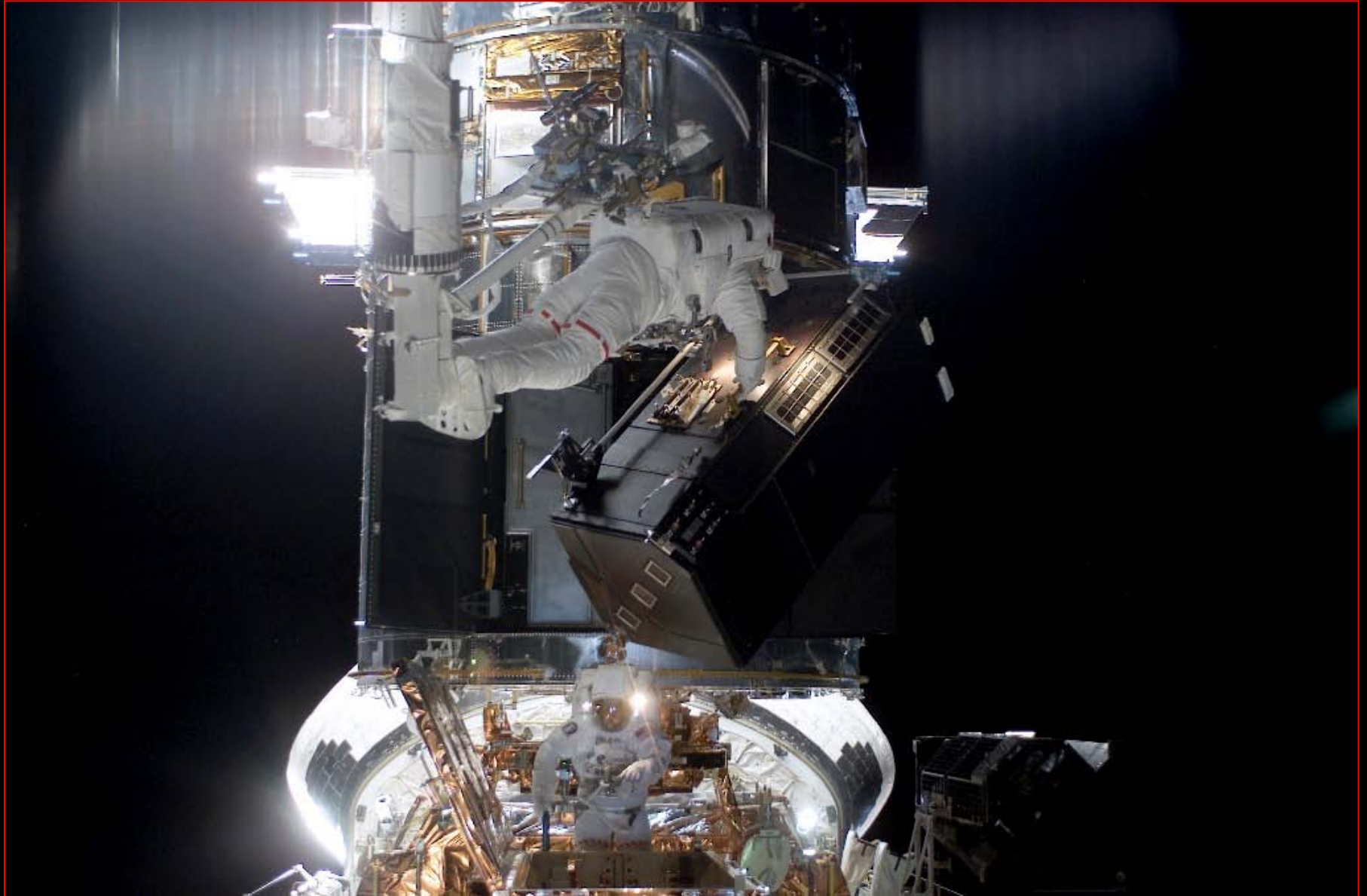
Grunsfeld, who has visited the Hubble three times on repair assignments (including eight spacewalks), applied the last human touch to a project that has been the culmination of his multidiscipline career.

The telescope is expected to function with enhanced capabilities for at least five more years before it is decommissioned and guided by a robot craft in a fiery descent to the Pacific Ocean.

As the Obama administration evaluates the future of NASA's manned space program, the final mission to Hubble echoes the experiences of earth-bound explorers over the ages: Machines can assist humans, but not replace them.

That's a message that Houstonian and former shuttle commander Charles F. Bolden Jr. — named on Saturday by President Obama to be the next NASA administrator — will be well qualified to deliver upon assuming his new post.

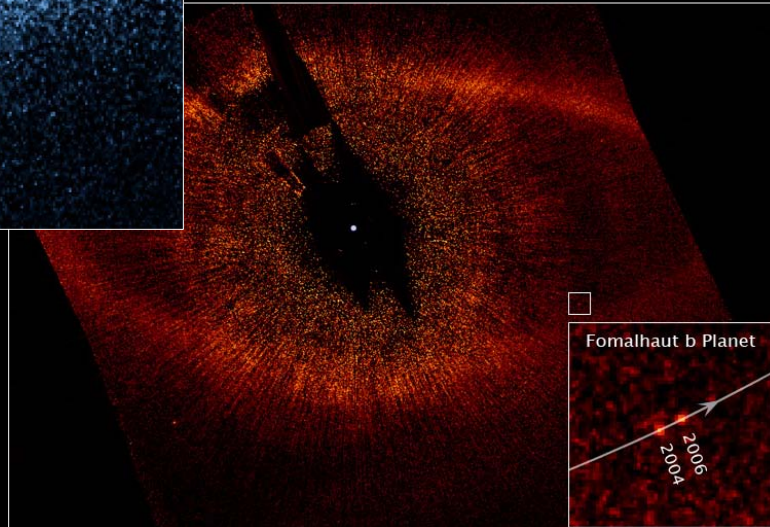
# Working in a Vacuum



# Recent Hubble Science



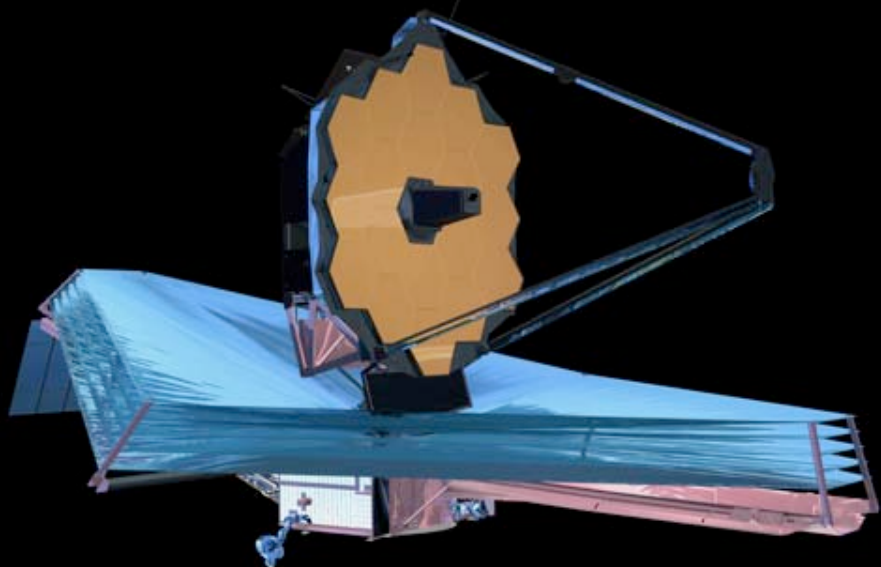
Asteroid belt collision:  
P/2010 A2



First visible-light image  
of an extrasolar planet:  
Fomalhaut b

Galaxies when the universe  
was just 600 million years old:  
HUDF WFC3/IR





# The James Webb Space Telescope

- Deployable infrared telescope with 6.5 meter diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch June 2014 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2
- 5-year science mission (10-year goal)



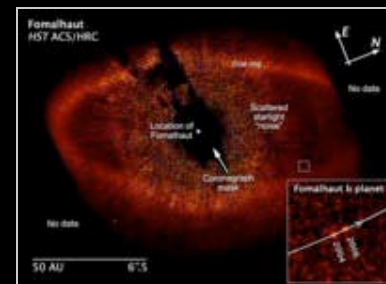
First light



The assembly of galaxies



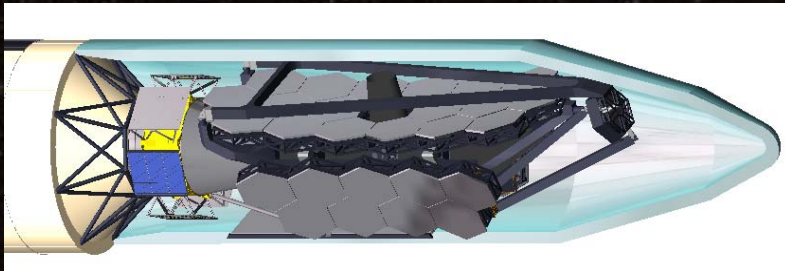
Birth of stars and planets



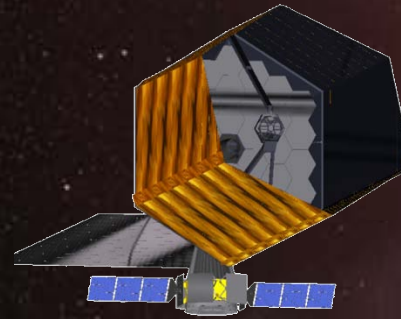
Planets and the origins of life



# “Are We Alone?”



Telescope folded in 10m fairing on Heavy Lift Booster.

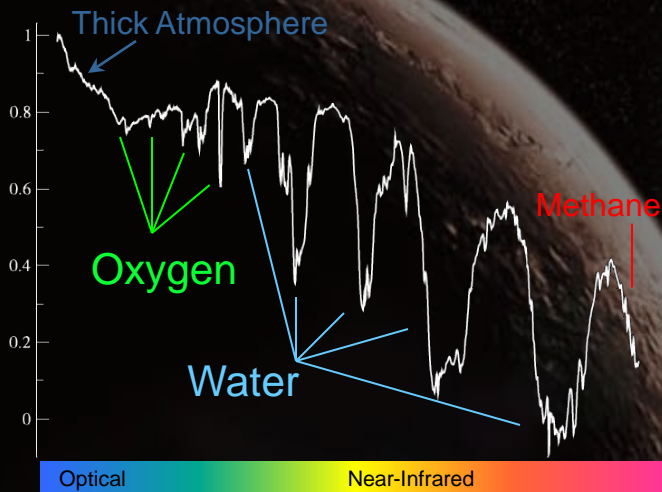


16-meter Space Telescope

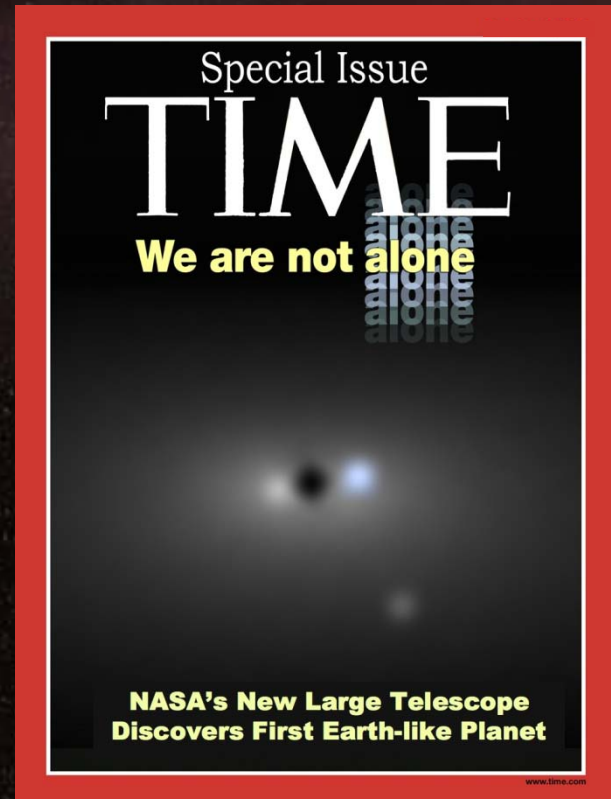


Hubble Space Telescope  
(to same scale)

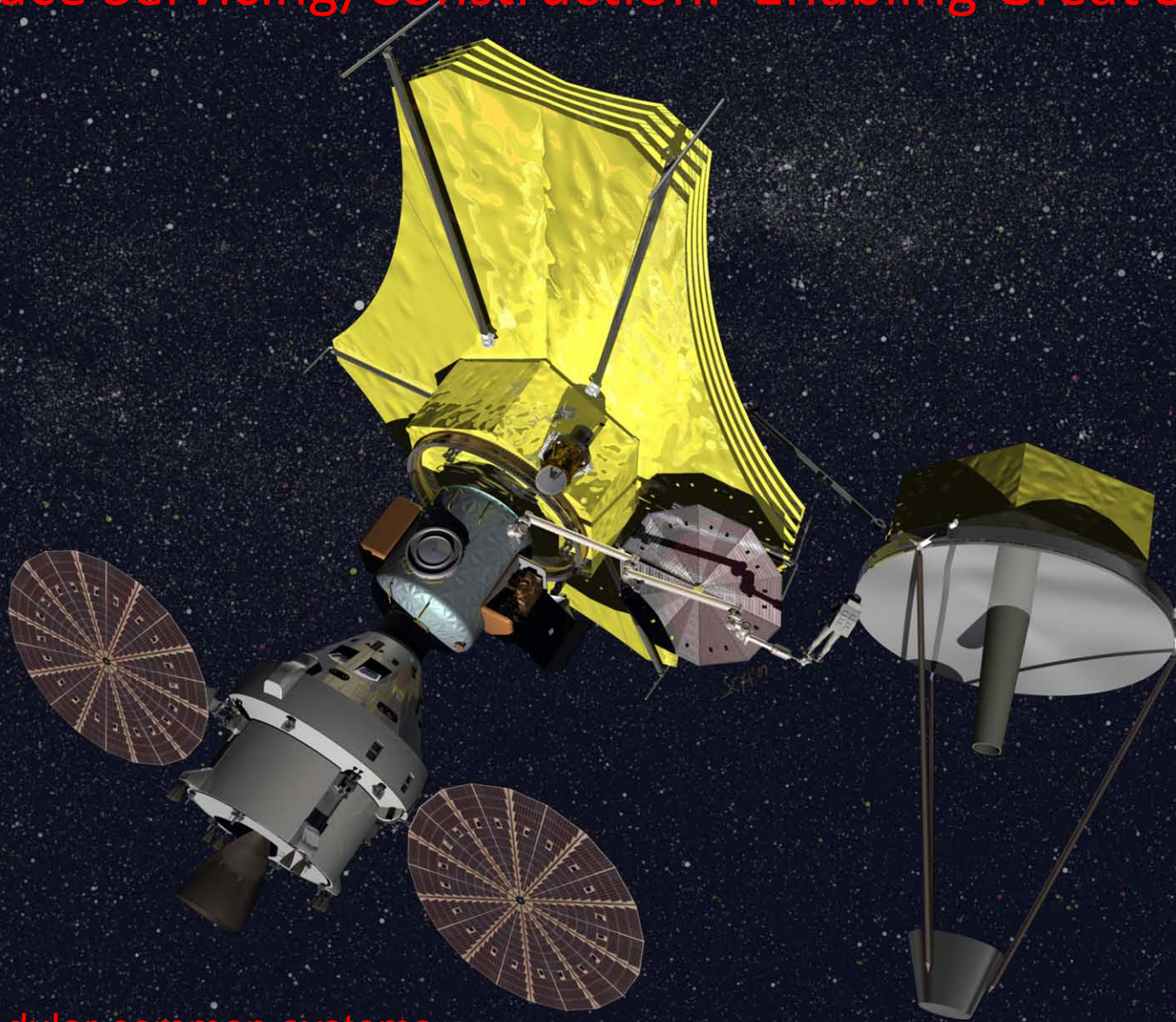
A large space telescope is *required* to detect life on exoplanets.



The signature of life is encoded in the spectrum of the Earth



# Space Servicing/Construction: Enabling Great Science



Modular common systems

# Inspiring Us All



## A large group of Mission Control Center staff posing for a photo. In the foreground, two men hold commemorative plaques. The background features large screens displaying flight data, a world map, and NASA logos.



# How to proceed?

- Cost effective Low Earth Orbit transportation. The journey starts and ends to/from LEO.
- Heavy Lift to enable new realms of exploration *and science*.
- Modular Exploration architecture.
- Frequent and compelling missions.
- Creative partnerships: NASA with International Partners, government, contractors, commercial and academic institutions.

*For I dipped into the future,  
far as human eyes could see  
Saw the vision of the [new] world[s]  
and all the wonder that would be  
--Tennyson*

**Innovate  
Explore  
Discover  
Inspire**

